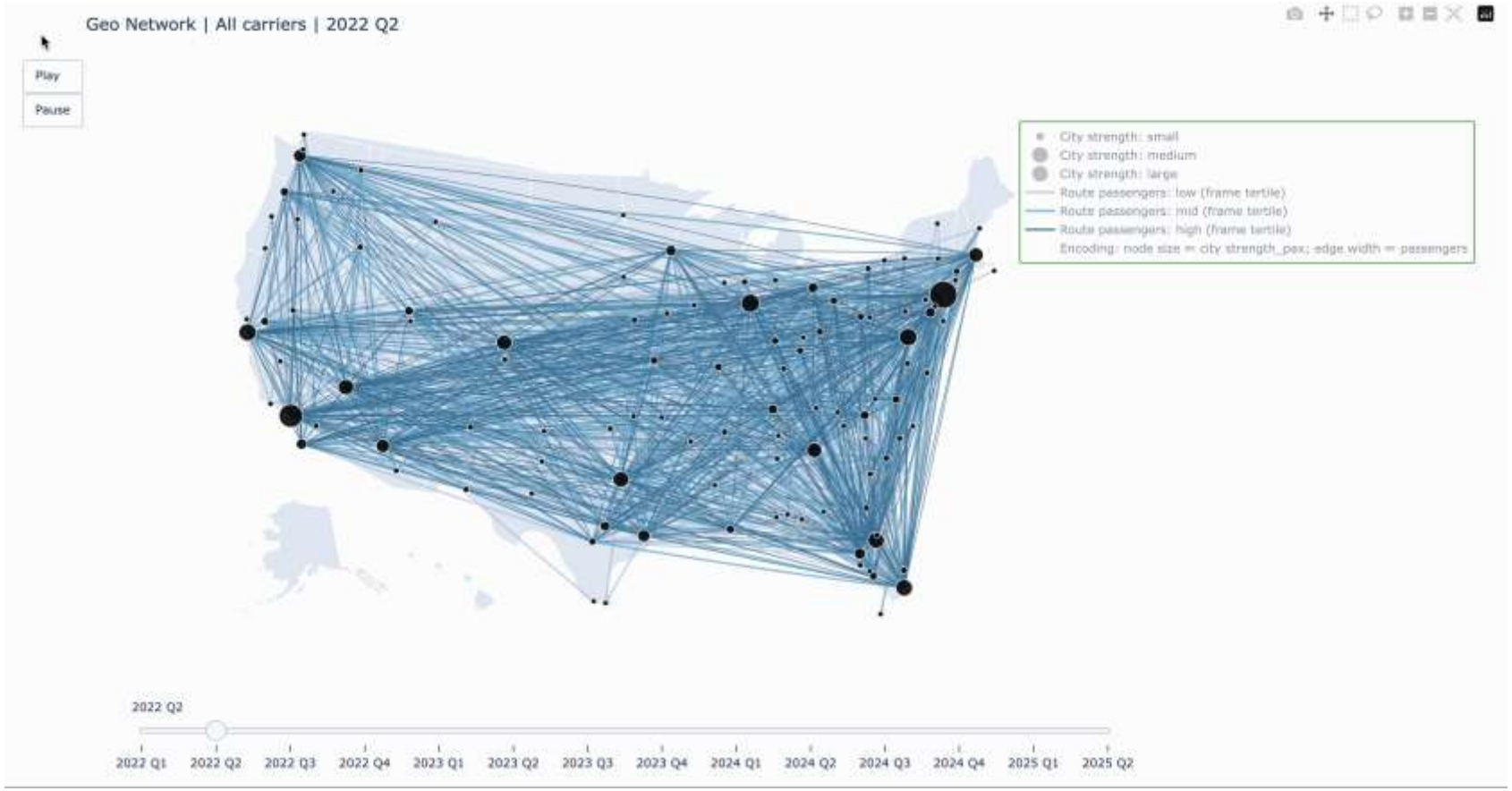
AIRFARE MARKET UNDER PRESSURE

a research from Group 31

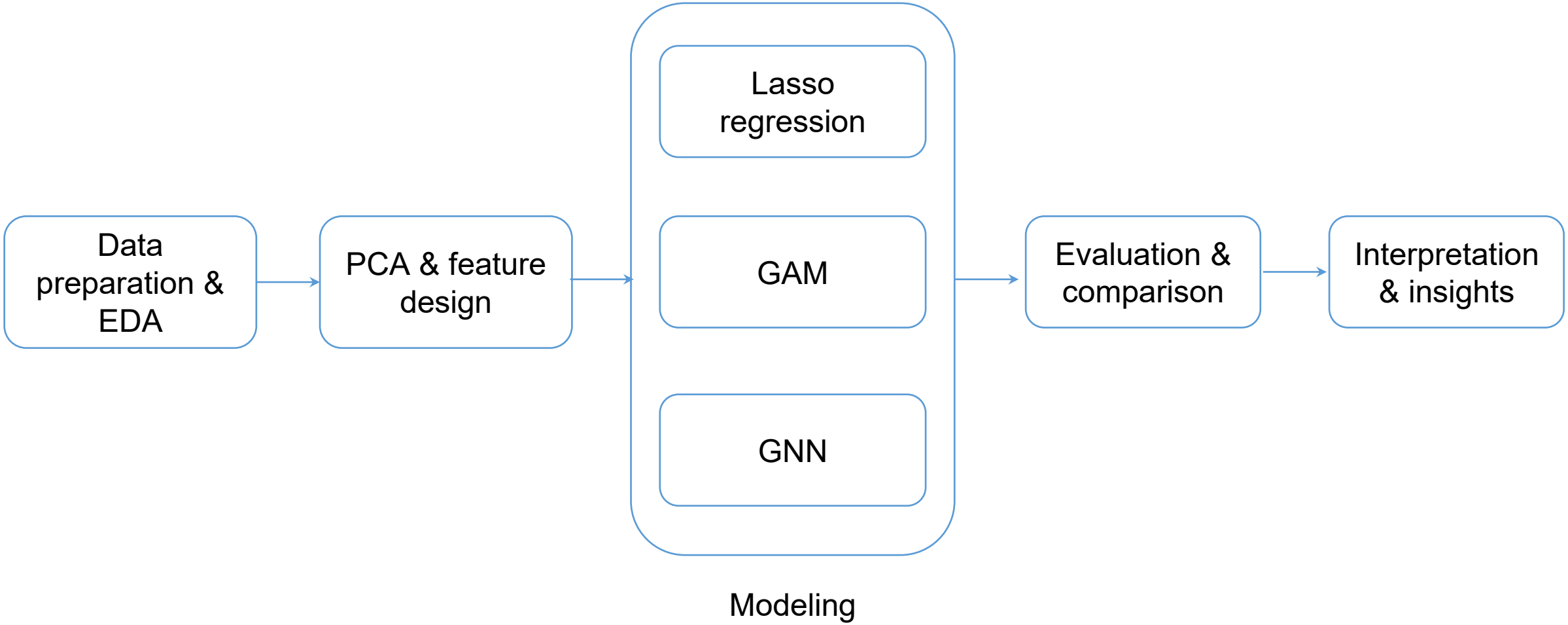


Raw Observation

- There are aviation hubs, and also small nodes connect to each others
- Route distance are varies

Potential Influence Factors

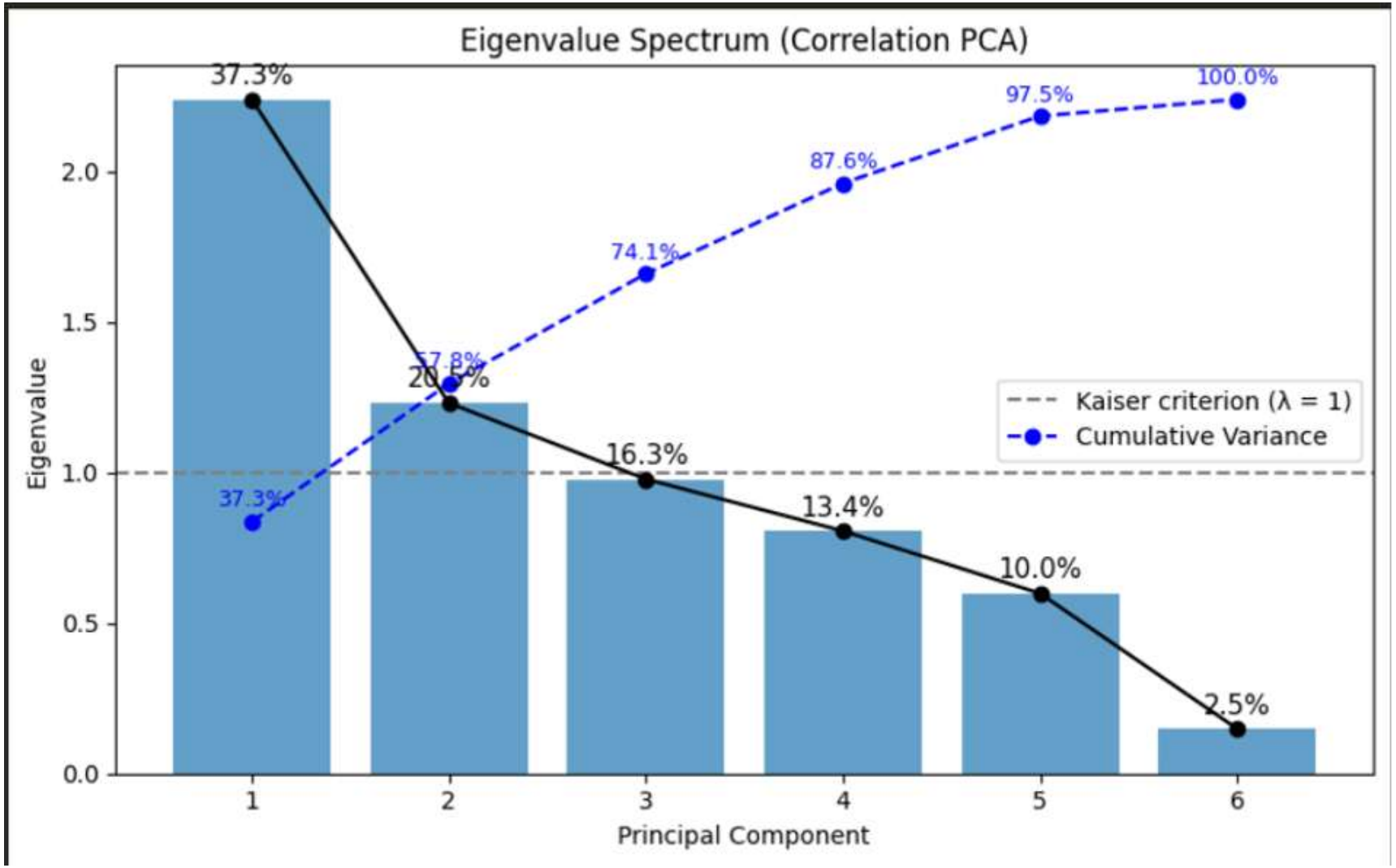
- route distance
- passenger number
- market competition
- carrier dominance


Data preparation & EDA
PCA & feature design
Lasso regression
GAM
GNN
Modeling
Evaluation & comparison
Interpretation & insights

We define the following variables:

- **city strength**: aggregate total number of passengers
- **fare**: Overall average fare paid by fare-paying passengers in the city-pair market
- **passengers**: Average number of one-way passenger trips per day in this city-pair market
- **nsmiles**: Nonstop market distance between the two city markets
- **rl_pax_str**: absolute difference between city strength of two connected cities
- **tot_pax_str**: sum of city strength of two connected cities
- **large_ms**: Market share of the largest-share carrier on the route
- **if_ms**: Market share of the lowest-fare carrier on the route

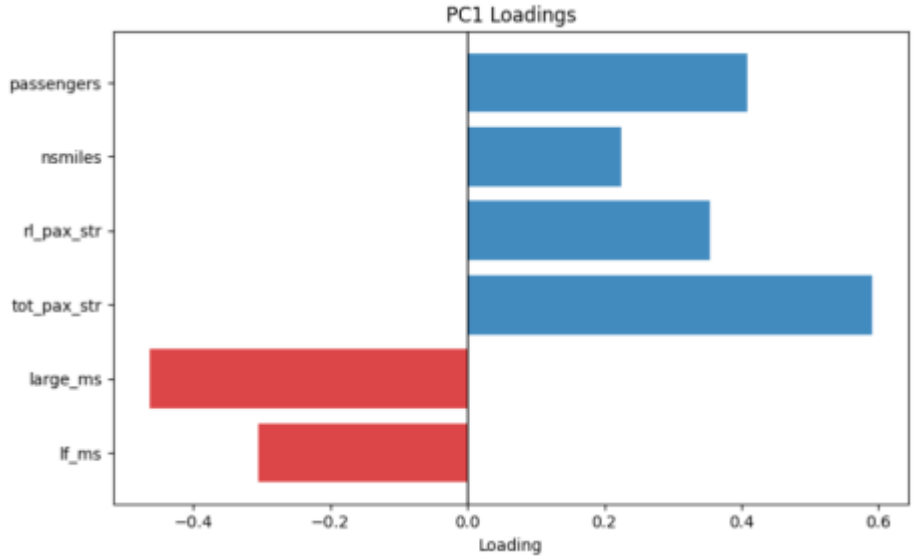
Eigenvalue Spectrum

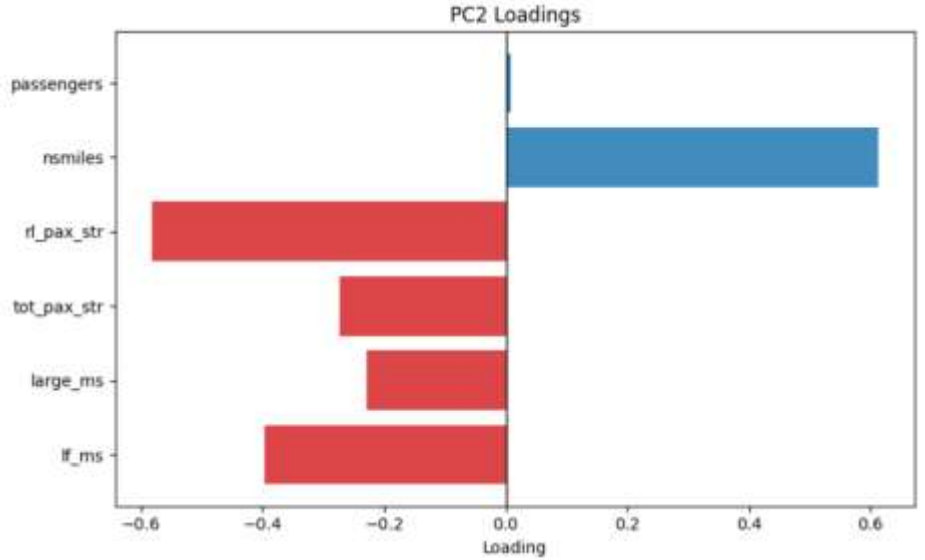


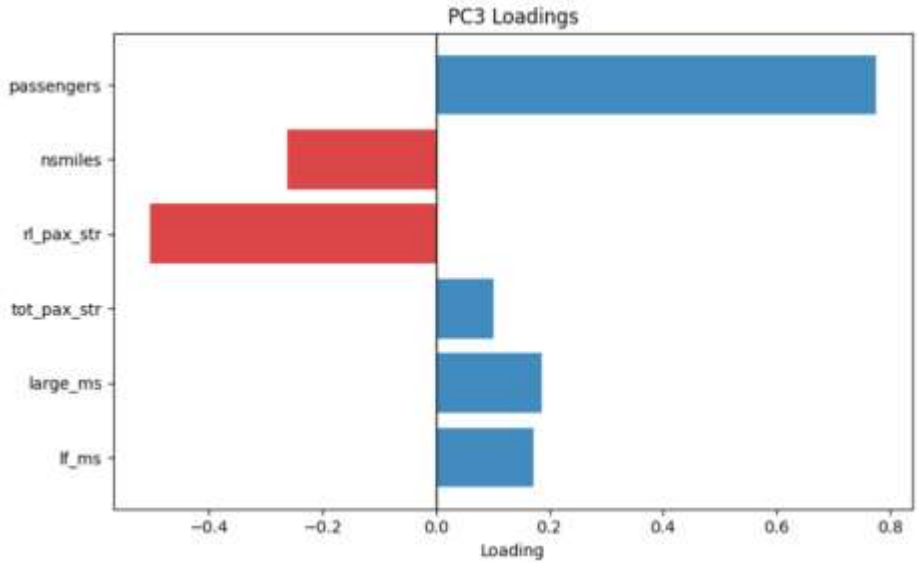
- PC1–PC3 explain:

~74% total variance

PCA Loadings

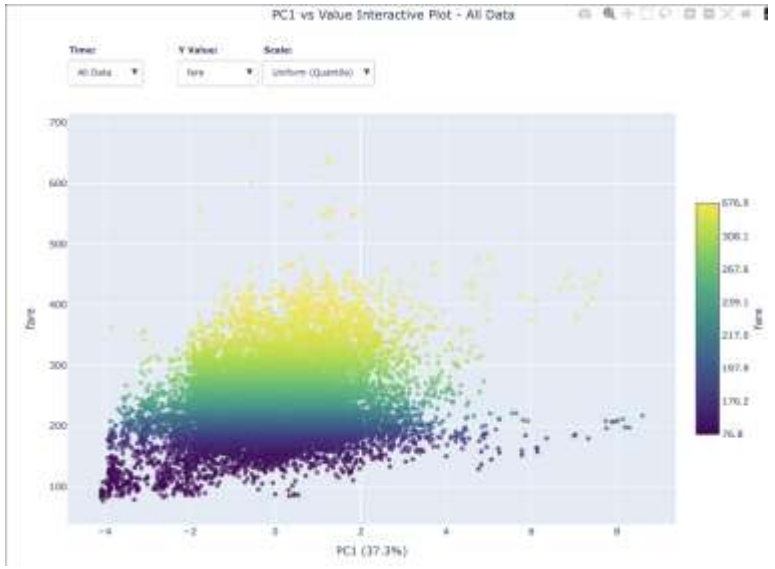


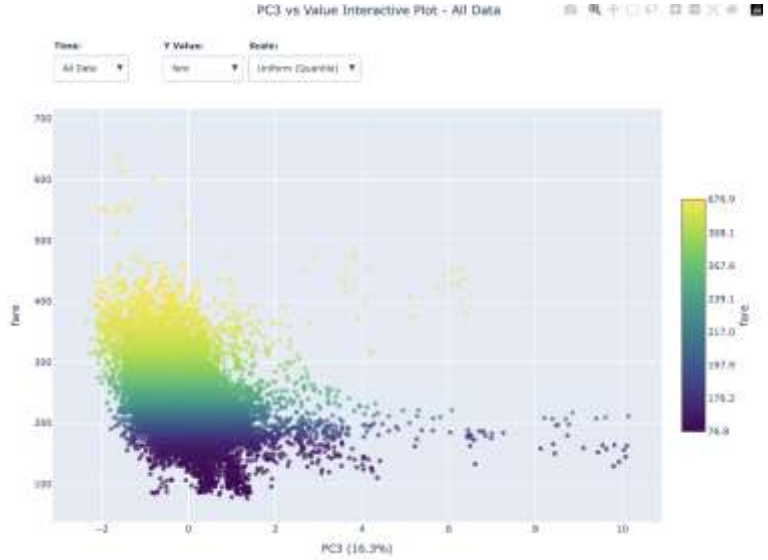


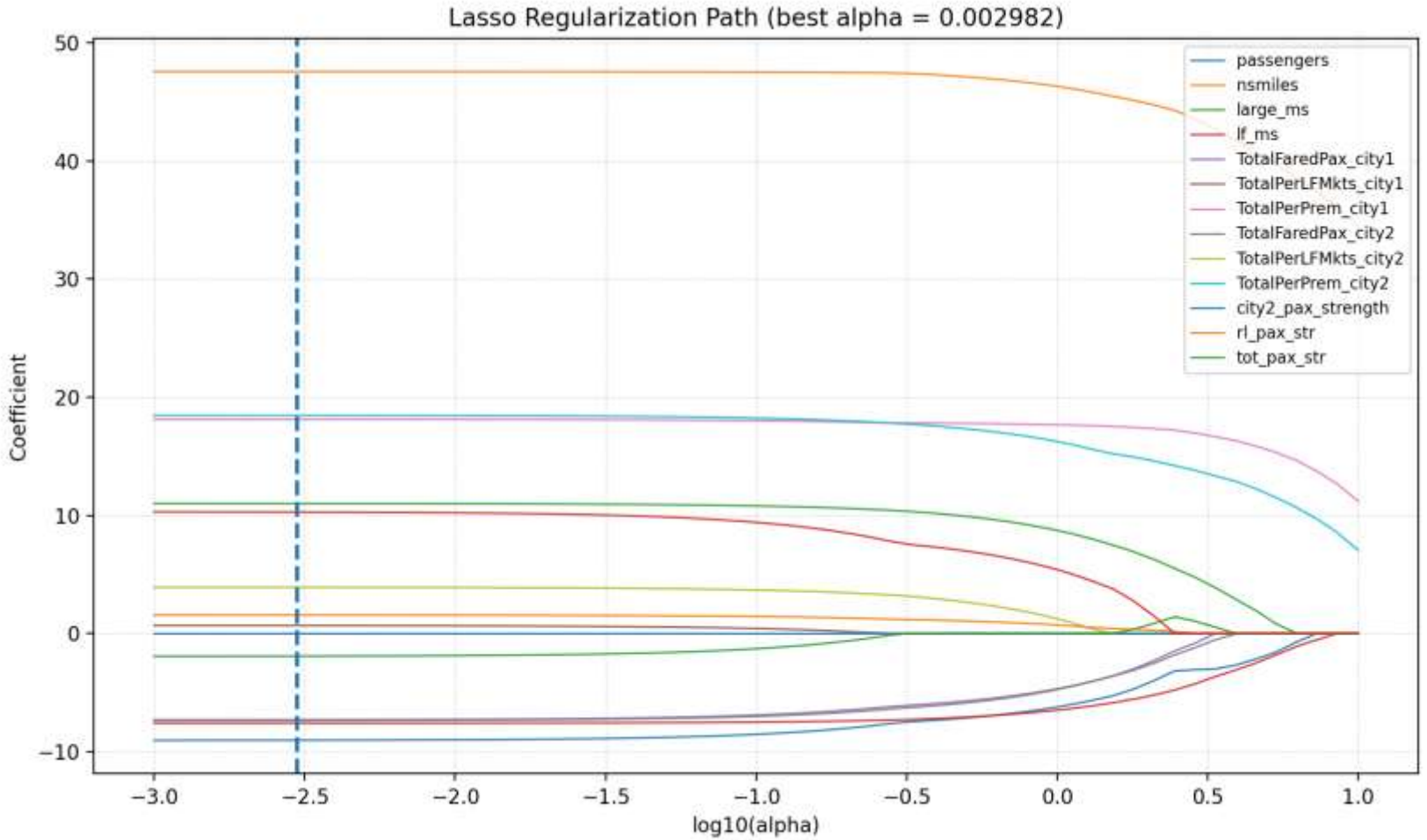


- PC1: Overall market scale vs competitiveness
- PC2: Distance-driven structure vs strength imbalance
- PC3: Short-haul volume vs market imbalance

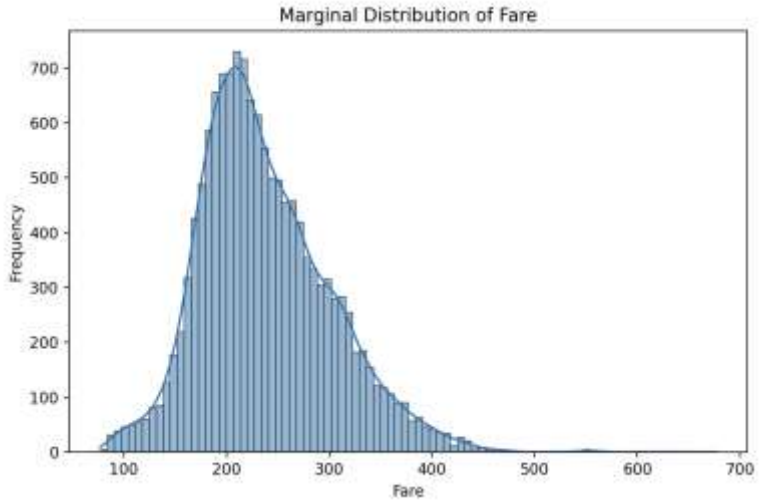
PC scores vs fare



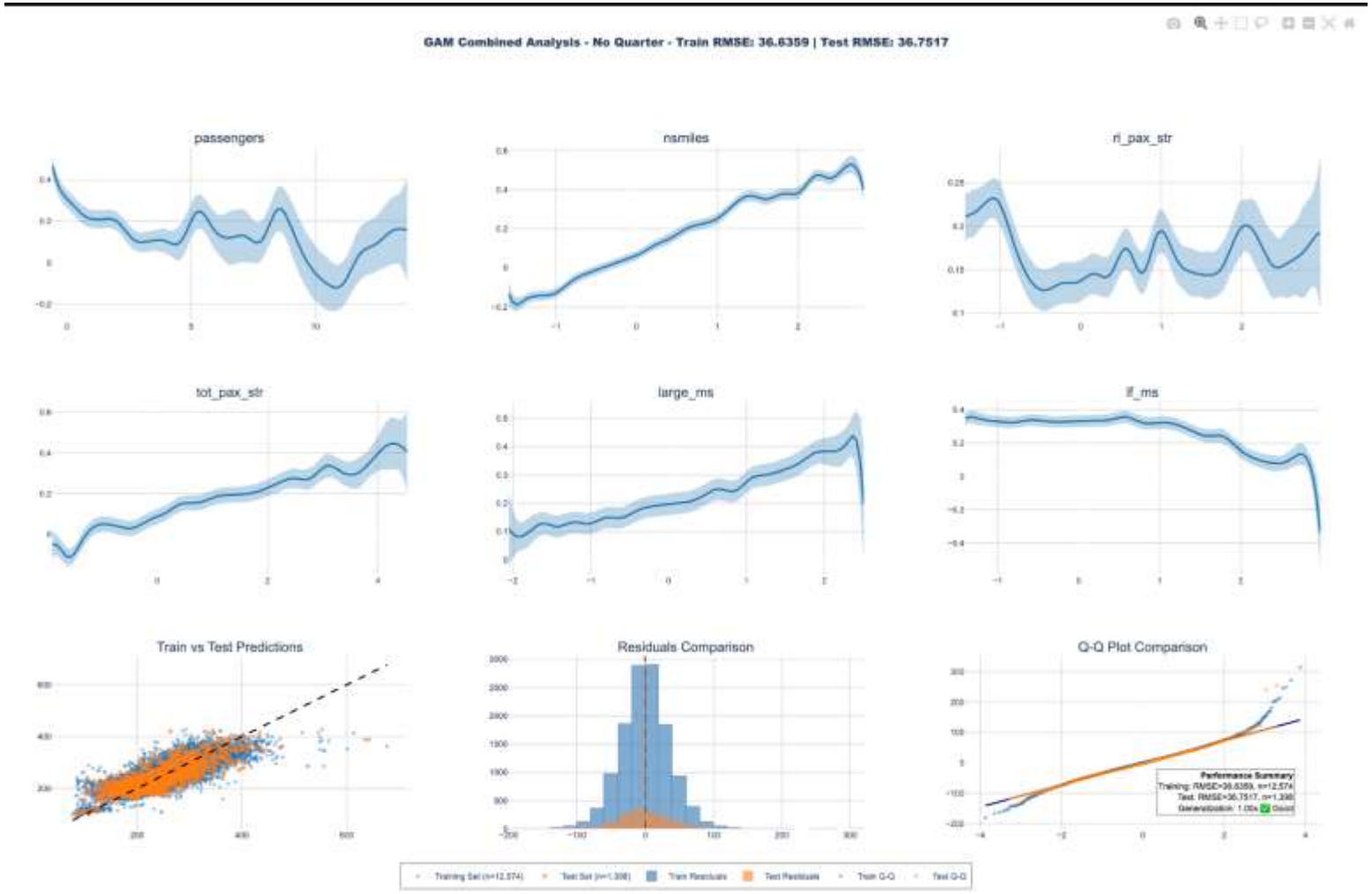




Lasso Result	
RMSE:	38.375076
MAE:	29.218121
	(test_n=1398)

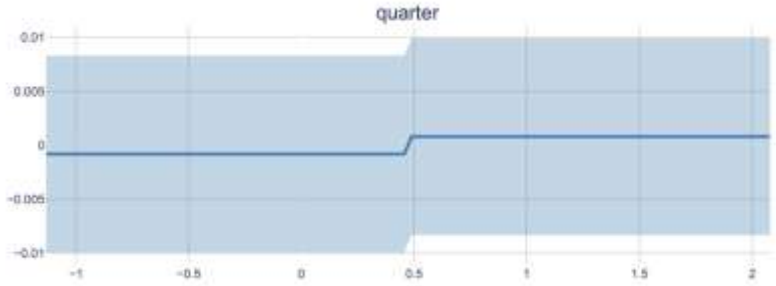


Raw Variable Gamma Error GAM Analysis GAM

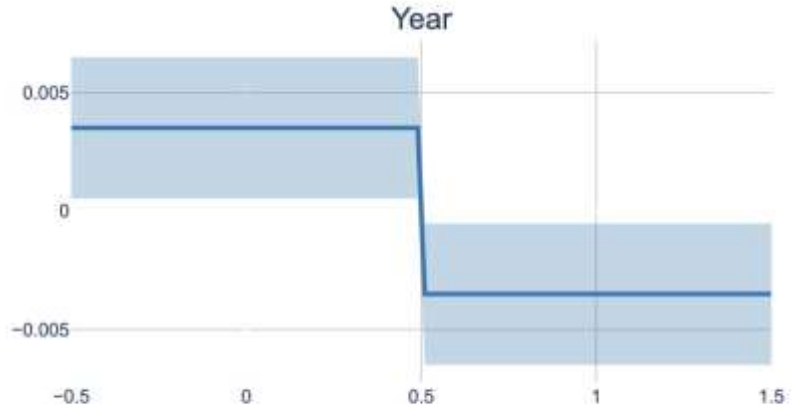


Time Dependent Gamma Error GAM Analysis GAM

1. Add quarter only

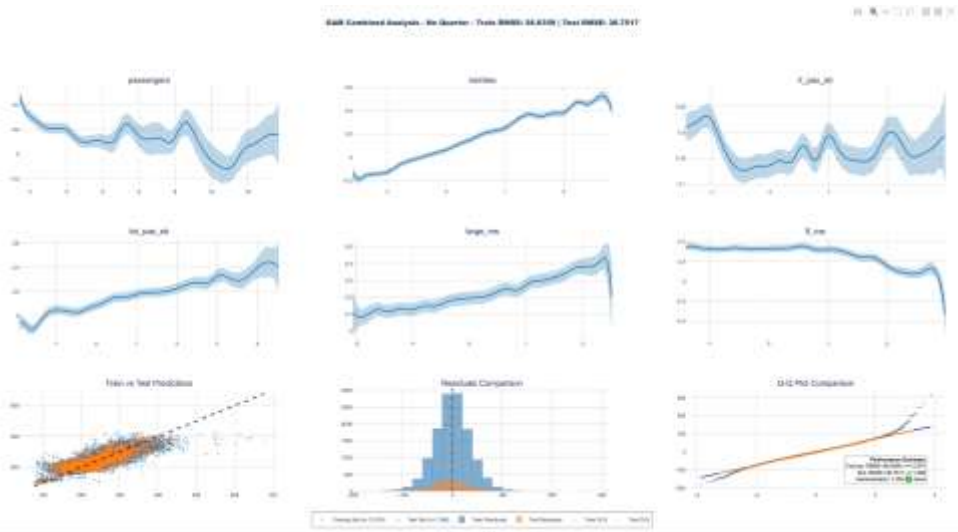


2. Add year only



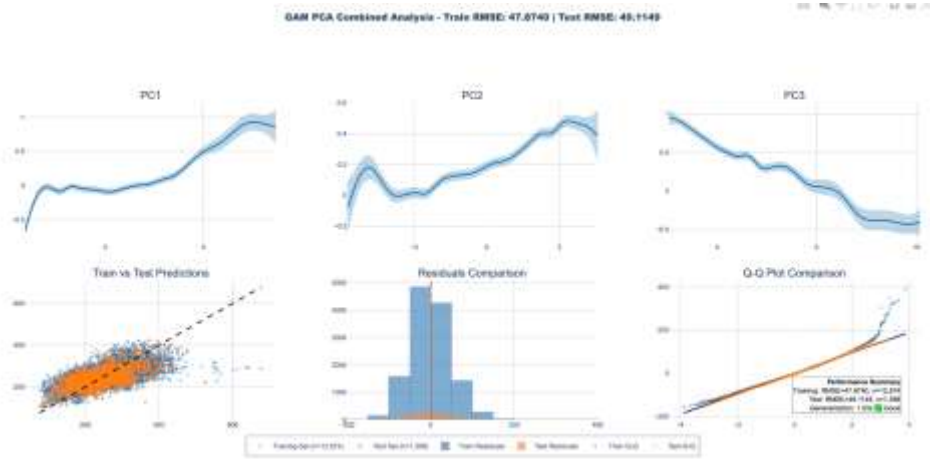
3. Add quarter and year

4.Curve Comparison (same curves)

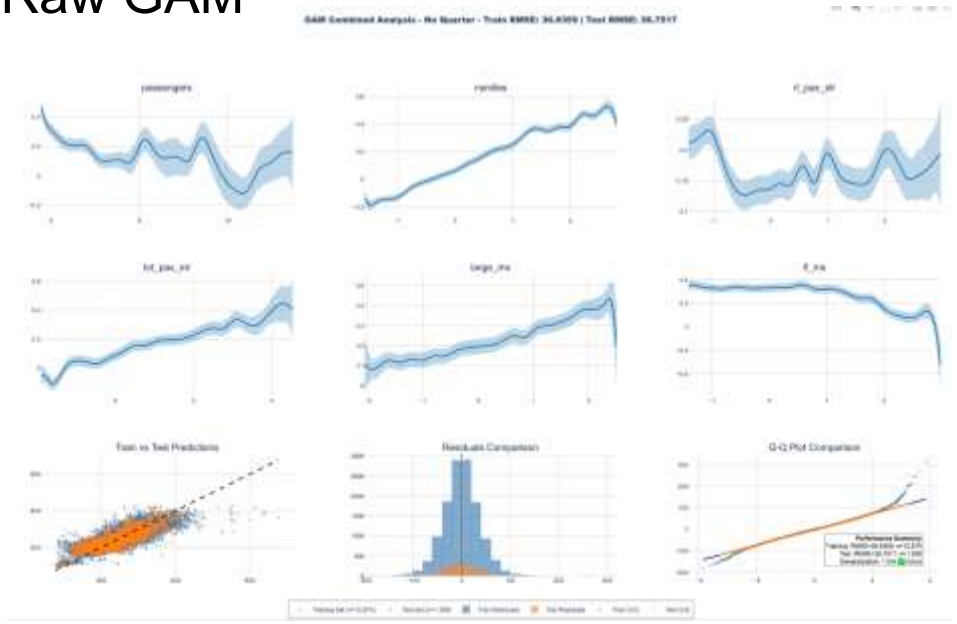


PCA Dependent Gamma Error GAM Analysis GAM

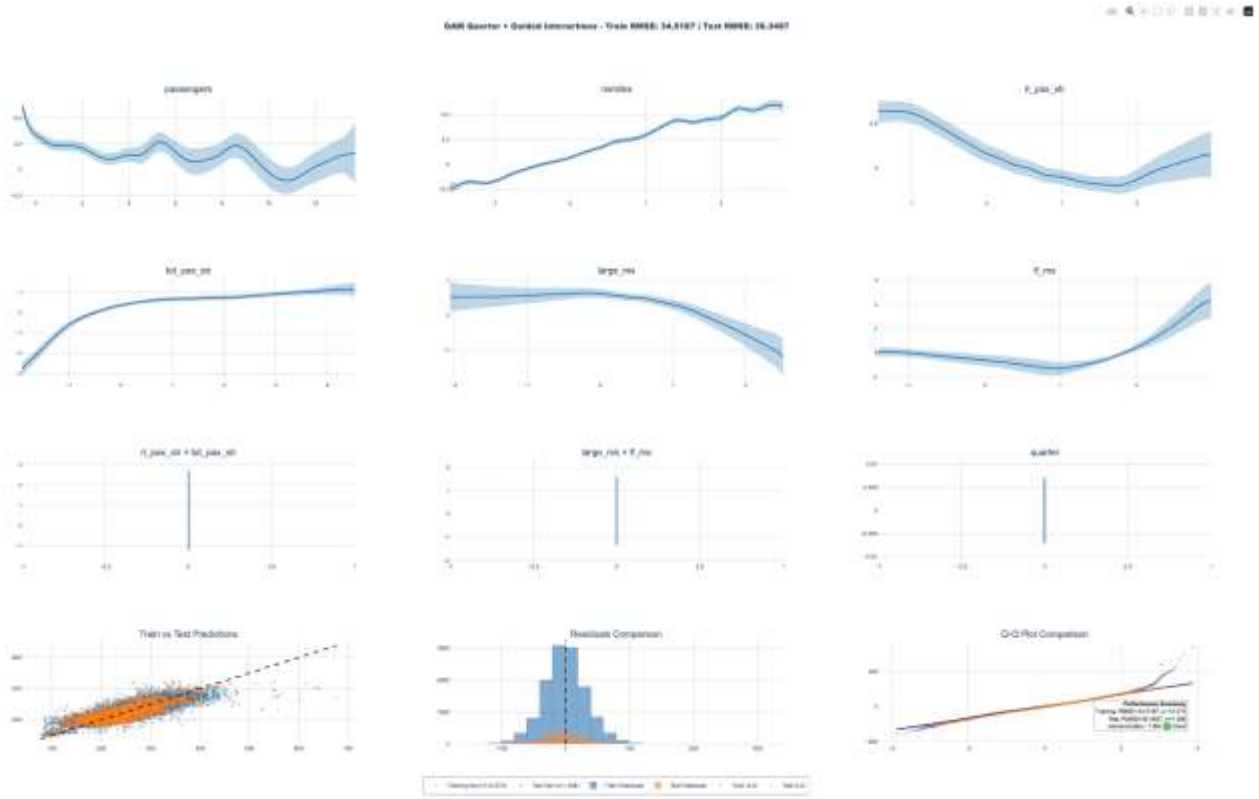
1. GAM on PCA



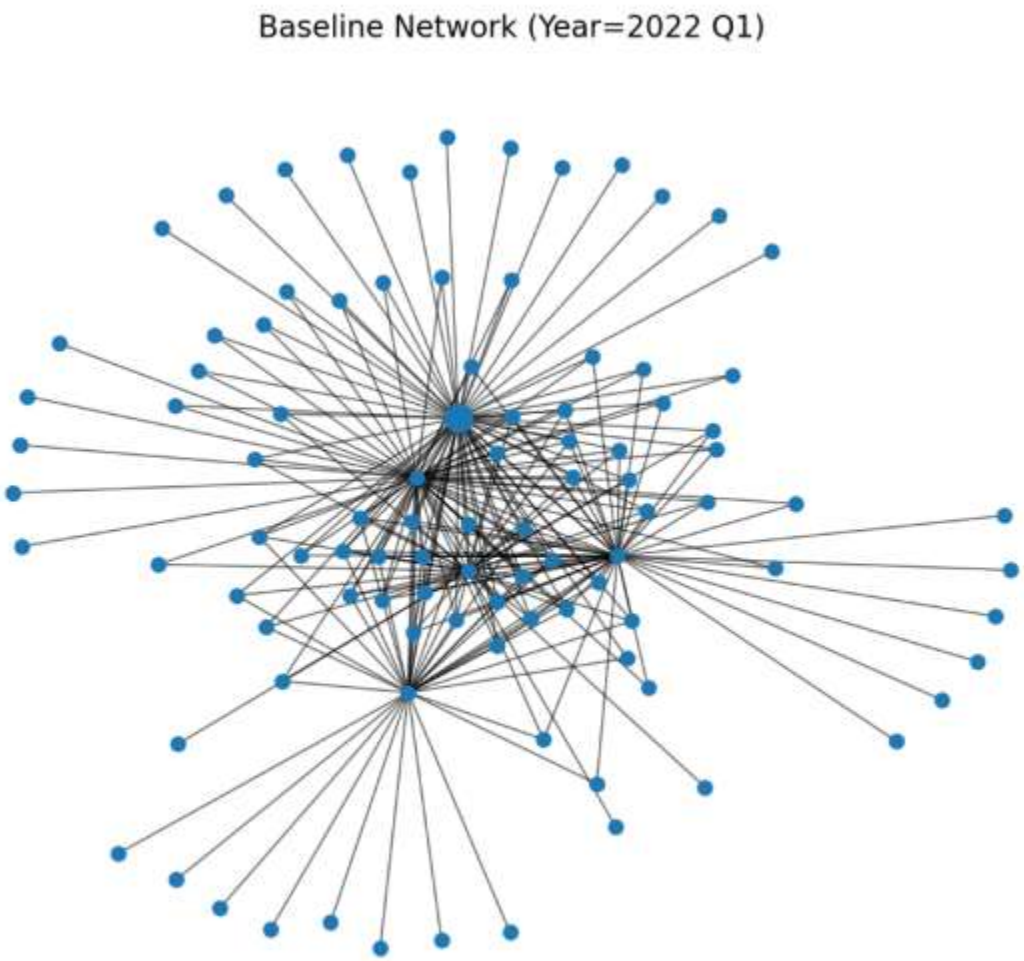
2. Raw GAM

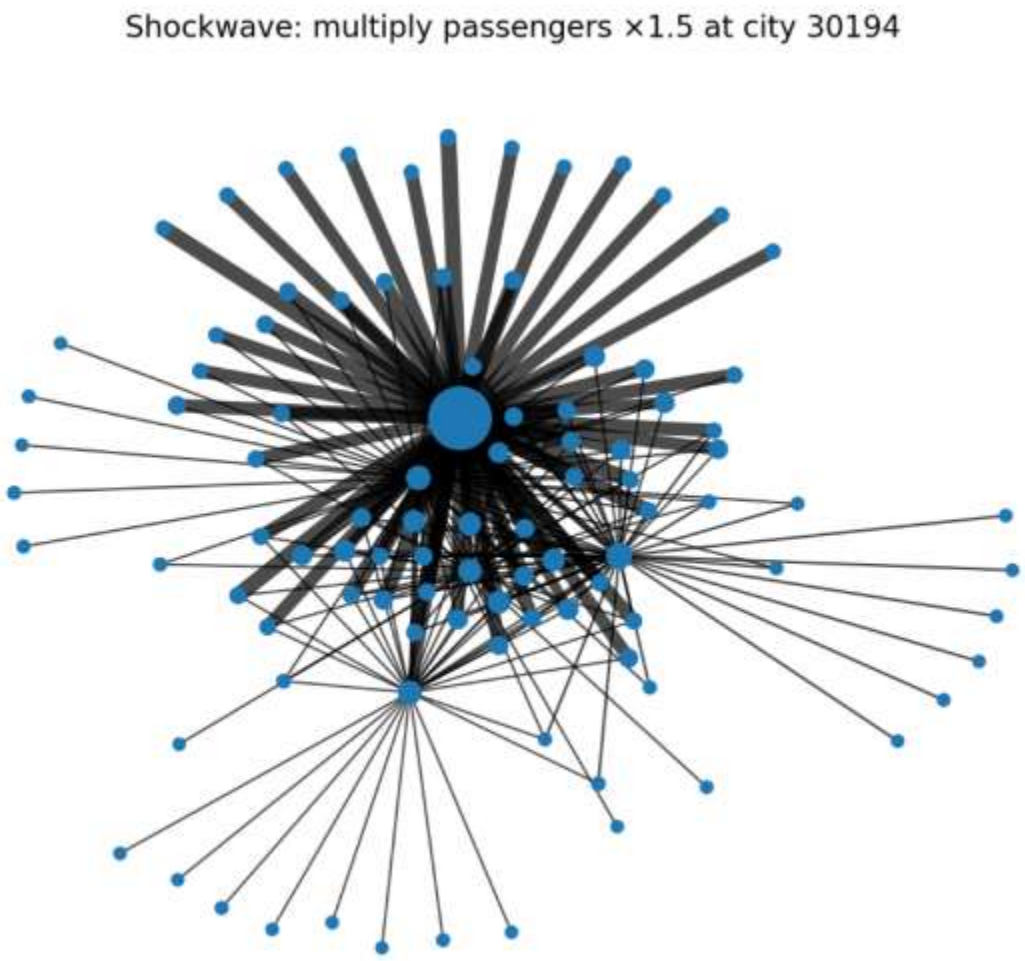


3. Add PCA guided interactions



MetaLayer


Baseline Network (Year=2022 Q1)


Shockwave: multiply passengers ×1.5 at city 30194

Thank you!

Questions?

References and Acknowledgement

- Reference:
  - **Dataset from U.S. Department of Transportation airfare reports from 2021 to 2025 (Q2)**, Originally available at: https://www.transportation.gov/policy/aviation-policy/competition-data-analysis/reports-statistics
  - **PyG Team.** (2026). *torch_geometric.nn.models.MetaLayer*. *PyTorch Geometric Documentation* (v2.8.0).

- Acknowledgement:
  - In this study we acknowledge to use Generative AI (including ChatGPT and Claude) to help in coding and phrasing.